Low-temperature radiation effects and surface phenomena in the wide-bandgap materials

Ionizing irradiation and irradiation with particles of different types (neutrons, protons, ions, *etc.*) plays an important role in a targeted modification of solid materials to improve their functionality, and also allows a thorough analysis of their various bulk and surface-related properties just using radiation as a tool for advanced material characterization. The most striking example of the latter is the use of synchrotron radiation, to which, in particular, in this issue is devoted to as many as 4 articles. This special issue of the Low Temperature Physics journal is dedicated to both low-temperature radiation effects and low-temperature measurements of various functional properties, to different surface phenomena and to always necessary and important *ab initio* calculations.

For performing such research with the use of many traditional and modern experimental methods, materials were often irradiated with photons (from IR to VUV, UV region of the spectrum), x and γ rays, fast electrons, fission neutrons, *etc*.

As a rule, and this is well known, the energy absorbed by a material during irradiation is only partially used for the luminescence excitation, which is widely used in scintillators, dosimeters and phosphors for enormous range of applications, while a significant part of the gained energy can manifest itself in the creation/transformation of structural defects. Impurities or additives always play a very important role in all these processes that is a reason why they analyzed in detail in almost every second article.

In total, this issue consists of 15 regular articles, which cover a very broad class of wide-bandgap materials. Model single alkali and alkaline-earth halides considered in the papers Zhanturina *et al*., Eglitis *et al*., Lisitsyna *et al*. are widely used for production of glasses and glass ceramics reviewed by Antuzevics, which are very important in different applications. Complex oxides with a perovskite structure studied by Piskunov *et al.*, Hamalii *et al.*, Rusevich *et al.*, Eglitis *et al.*, and with the spinel structure analysed by Mironova-Ulmane *et al*., single crystals of ScF_3 with negative expansion observed by Pankratova *et al.*, tungstates solid solutions $Zn_cNi_{1-c}WO_4$ investigated by Bakradze *et al*., catangasite (Kozlova *et al*.), aluminoborate $TbAl_3(BO_3)_4$ (Peschanskii *et al*.), $CdPS_3$ (Kuzmin) and lastly, polymer-based nanocomposites created and studied by Karbovnyk *et al*. are the materials, which open many prospects in all-encompassing range of applications.

The first two comprehensive papers of Antuzevics and Mironova-Ulmane *et al*. are devoted to the advanced EPR characterization of erbium in glasses and glass ceramics providing up-conversion luminescence and Cr^{3+} ions in natural $MgAl_2O_4$, respectively. The last study of the effect of neutron irradiation on the EPR and photoluminescence spectra of chromium ions in natural spinel was of particular interest.

One more advanced experimental method — the low-temperature reflection high-energy electron diffraction (RHEED) enabled the authors of the paper Hamalii *et al*. to study the intrinsic nanostructures formed on atomically smooth surfaces of $SrTiO_3$. In contrast with perovskite films and ceramics, which are very popular due to numerous usages in the nanoelectronics and nanotechnologies, the proposed nanostructures on a single crystal surfaces are predictably ordered that opens new prospects for applications when the well-controlled nanoscale architecture is required. The experimental data on efficiency of radiation defect stabilization measured by the unique method of the low-temperature stresses in luminescence studies are discussed in detail by Zhanturina *et al.*

The interest in the physical properties of rare-earth aluminoborates such as $TbAl_3(BO_3)_4$ single crystals is caused by their nonlinear optical behaviour, which, combined with their high chemical and mechanical strength, makes it possible to use them for frequency doubling, in lasers, mini-lasers and other devices. The vibrational and luminescence properties as well as Raman spectra of the $TbAl_3(BO_3)_4$ single crystals were studied in the temperature range of 5–300 K by Peschanskii *et al.*

Many conventional experimental methods, such as luminescence, optical absorption, EPR and Raman, the opportunities of synchrotron radiation techniques are also demonstrated. Several articles in this issue are devoted to the research performed using synchrotron radiation (Kozlova *et al.*, Pankratova *et al.*, Bakradze *et al.*, Karbovnyk *et al.*). In particular, VUV spectroscopy studies of ScF_3 with negative-expansion (Pankratova *et al.*), CdI_2 scintillators (Karbovnyk *et al.*) and catangasite (Kozlova *et al.*) were performed at DESY and MAXIV synchrotron radiation facilities, while x-ray absorption spectra of tungstates solid solutions $Zn_cNi_{1-c}WO_4$ ($c = 0.0-1.0$) were measured at the HASYLAB DESY C1 bending-magnet beamline (Bakradze *et al.*). Where necessary, the obtained results were supported by the other experimental methods such as SEM, TEM and x-ray diffraction.

Special attention was also paid to modern *ab initio* theoretical methods of the electronic band structure calculations, using Crystal code (Piskunov *et al.*, Rusevich *et al.*, Eglitis *et al.*, Kuzmin *et al.*). In particular, powerful capabilities of the applied theoretical methods have been demonstrated by the several detailed calculations of structural, electronic and vibrational properties of $BaTiO_3$ and $SrTiO_3$ perovskite and alkaline-earth fluorides including their anion vacancies in the bulk and on the surface (Rusevich *et al.*, Eglitis *et al.*). The models with some important dopants, such as Mn in $YAlO_3$ crystals, which are known as the promising dosimetric materials, are also calculated (Piskunov *et al.*).

To summarize, this issue clearly demonstrates the great progress achieved in recent years both in the study of the radiation properties of a wide class of materials possessing the wide-bandgap and in the modern radiation research methods of the studied materials both new and well-known for decades.

We are absolutely confident that this issue will be useful for the wide community of researchers actively working in the field of the material physics and chemistry.

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